Geostatistic analysis of humus stocks in fallow soils taking into account spatial heterogeneity

Giniyatullin K.G., Sahabiev I.A., Smirnova E.V.

Kazan Federal University, Department of Soil science, giniyatullin@mail.ru

Keywords: fallow soils, spatial heterogeneity of humus stocks, geostatistics

DOI:10.36291/HIT.2021.021

The danger of global climate change on the Earth associated with the accumulation of greenhouse gases in the atmosphere is one of the most serious challenges of our time. According to Batjes (1996), soils contain about 1500 Pg organic carbon. This is about three times the amount of carbon in the Earth's vegetation cover and twice the amount of carbon in the atmosphere. Naturally, an increase in the content of soil organic matter (SOM) is considered one of the most important potential sinks of atmospheric carbon in terms of preventing global climate change. Since the removal of land from arable turnover is a modern trend in the development of agricultural production in the world, including Russia, the accumulation of SOM under fallow vegetation can be considered as a very significant sink of CO₂ from the atmosphere. At the same time, a realistic assessment of the stocks of accumulated humus in fallow soils can hardly be given without an assessment of their spatial heterogeneity. The purpose of the work is to assess the total and accumulated reserves of SOM using interpolated maps of spatial heterogeneity of soil properties. The purpose of the work is to assess the total and accumulated stocks of SOM using interpolated maps of spatial heterogeneity of soil properties.

We studied two fallow areas (15-20 years old) under different fallow vegetation (birch forest and meadow grassland overgrown with forest). Samples were taken using a stratified randomized design in layers from the entire depth of the old arable horizon. The humus content and the bulk density were determined in the samples. For each site, three maps of heterogeneity of soil properties (the content of SOM in each layer, bulk density, and thickness of the old arable horizon) were constructed using various interpolation methods. These maps were used to create a map of total SOM stocks in the old arable horizon, as well as a map of accumulated stocks by the difference in humus content in the upper and lower parts of the old arable horizon. Assessment of SOM stocks in the old arable layer in territories occupying from several tens to hundreds of hectares is characterized by strong spatial heterogeneity, and in some areas, these stocks differ by more than two times. It was shown that the accumulated stocks of humus under the fallow of 15-20 years old form more than 20% of the total humus stock in the old-arable horizon. Studies have shown that the type of fallow vegetation (deciduous forest and meadow vegetation) had an insignificant effect on the accumulated stocks of humus. The qualitative composition of SOM accumulated under fallow vegetation was studied using various spectroscopic, analytical, and incubation methods. It was shown that the organic matter newly formed in the old arable horizon is represented by labile (unstable) fractions that are easily subject to oxidation and microbial decomposition.

The area of fallow lands in modern Russia, according to various estimates, ranges from 20 to 40 million hectares. It is obvious that an unregulated return to arable turnover of such lands can lead to an abrupt emission of CO₂ into the Earth's atmosphere due to the mineralization of SOM accumulated under fallow vegetation over the past decades.

Acknowledgements. This work was supported in part by the Russian Foundation for Basic Research, research project № 19-29-05061-mk